Physician Learning and Best Practice Adoption: An Application To Cesarean Sections

March 2003

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Abstract

Small area variation studies have demonstrated that people receive a substantially different amount of medical care depending on where they live, controlling for differences in prices, income, and health. Using a data set that contains the universe of hospital admissions in Florida over a 9-year period and consistent physician identifiers, we examine why physicians appear to have such varied beliefs regarding the efficacy of treatment methods. Specifically, we examine the extent to which an obstetrician's risk-adjusted c-section rate is determined by where he trained as a resident, his peer group's c-section rate, and his patients' health outcomes.

We find that physicians have distinct practice styles; the variation in the risk-adjusted c-section rate between physicians within a region is three times larger than the inter-regional variation. Although treatment styles are associated with where physicians trained, residency programs explain only four to six percent of the variation between physicians in c-section rates. We find evidence that physicians, particularly inexperienced physicians, respond to the practice style of their peer physicians, although the magnitude of this effect is fairly small. Physicians also appear to alter their practice style according to their patients' health outcomes, and this effect is similar in magnitude to the peer group effect. These results indicate that herding behavior is not the primary cause of inter-regional variation in the c-section rate.

This paper has benefited from comments by Steven Lehrer, George Macones, and members of the Wharton Applied Economics workshop, the University of Pennsylvania Population Studies Center Colloquium, and the Brigham Young University workshop. We thank the University of Pennsylvania Research Foundation and the Leonard Davis Institute for Health Economics for providing funding to acquire the data.

There is an extensive literature demonstrating that people in the United States receive a substantially different amount and type of medical care depending on where they live (Wennberg and Gittelsohn, 1973; Wennberg, Freeman, and Culp, 1987; Phelps and Parente, 1990). In most of these small area variation studies, analysts calculate the use rate of a particular treatment (e.g., back surgery) in different geographic markets, controlling for demographic characteristics of the population, and then calculate the coefficient of variation in use rates across markets. Phelps and Mooney (1993) examine several possible explanations for why the use rates differ so substantially: differences between markets in income and prices, differences between markets in physician ability or willingness to induce demand for their services, differences in patient preferences, and unmeasured health differences. Phelps and Mooney conclude that these factors collectively explain very little of the differences in the amount of medical care received; the primary explanation is differences in physicians' "beliefs about the efficacy of treatment and decisions about which patients should receive treatment."[1]

If there exists a single best practice for treating patients of a particular type, then consumer welfare would be reduced when practitioners deviate from this standard. Phelps and Mooney (1993) estimate there is a $33 billion welfare loss per year (1987 dollars) due to variations in inpatient use rates.[2] This represents an underestimate of the true costs if the mean observed use rate is not the optimal rate or if there is also intra-regional variation (e.g., variation across physicians).

There have been a handful of theoretical models in the health economics literature articulating why physicians in different markets might adopt divergent views regarding the

[1] Many other authors concur with the Phelps and Mooney (1993) assessment, including Chasin (1987), Bikhchandani *et al.* (2001), and Newhouse (2002).

[2] The difference in geographic use rates has also become an important political issue. When an elderly person enrolls in a Medicare HMO, the HMO receives a payment commensurate with the average medical costs in that market. Medicare HMO payments differ considerably across markets due to differences in patterns of care, consistent with the results of the small area variation studies. The Balanced Budget Act of

efficacy and appropriateness of medical care.[3] Phelps and Mooney (1993) argue that physicians are Bayesian learners; they update their prior belief regarding the appropriateness of a medical treatment or technology based on their own treatment decisions and patient outcomes, as well as their colleagues' treatment decisions and patient outcomes. Physicians may imitate their colleagues if their colleagues' treatment decisions and outcomes provide useful and inexpensive information. Phelps and Mooney argue that physicians will converge over time to a community standard, but community standards can differ because residency programs have unique medical styles and physicians may locate differently across markets. According to this model, in the long run there would be inter-regional variation in practice patterns but little intra-regional variation across physicians. In our sample of Florida obstetricians, however, we find that the intra-regional variance in cesarean section (c-section) rates across physicians is three times greater than the inter-regional variance in c-section rates.

In this paper we begin by measuring a physician's clinical style, defined as his risk-adjusted cesarean section rate, using a data set that contains the universe of hospital admissions in Florida over a 9-year period and consistent physician identifiers. We then examine whether, and to what extent, physicians' treatment styles are influenced by where they received residency training, their patients' health outcomes, and the treatment styles of a physician's peer group. Our data allow us to examine physicians' treatment decisions over a long time period, to characterize a physician's peer group, and to observe the treatment decisions of a physician's peer group.

Fournier, Prasad, and Burke (2002) develop a theoretical model where physicians may herd on a particular treatment method due to positive network externalities. In their model there

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1997 attempted to reduce the payment differences by market, in part because taxpayers in low-use areas were subsidizing those in high-use areas.

[3] There are also a number of theoretical papers in the general economics literature that demonstrate conditions under which an inefficient equilibrium may result from herd behavior, information cascades, and social learning (Banerjee, 1992; Scharfstein and Stein, 1990; Ellison and Fudenberg, 1993, 1995;

are many cities and two methods of treating patients with a particular illness (method A and method B). If the expected outcome for a patient using method A increases with the number of patients in that city who are treated with method A, physicians may treat all patients in that city with method A. Conversely, the different patient characteristics in another city may cause physicians to herd on method B due to the positive outcome externalities. As with the Phelps and Mooney (1993) model, we would expect little intra-regional variation in use rates. Physicians within a market should treat patients in a similar fashion. They test their model using data on Florida cardiologists' treatment decisions of heart attack patients and find that cardiologists are more likely to perform or recommend that patients receive a coronary angiography, bypass surgery, and angioplasty if their peer cardiologists are also likely to make such treatment decisions. This study uses a single cross-section, so it is difficult to interpret whether the positive peer effects are due to learning or unobserved patient characteristics that are correlated for a physician and his peer group. Our panel data set, on the other hand, allows us to control for time invariant unobservable characteristics.

Bikhchandani, Chandra, Goldman, and Welch (2001) argue that when a treatment decision is discrete (e.g., perform surgery or treat a patient medically) rather than continuous (e.g., dosage of a medication), there are fewer opportunities for physicians to learn by experimenting. In these settings, physicians may be more likely to discard their private information regarding the efficacy of a treatment and herd on a single treatment method. Thus, learning may cease altogether. They test this hypothesis and show that there is indeed more regional variation in whether acute myocardial infarction (AMI, or heart attack) patients receive bypass surgery or angioplasty (discrete decisions) than whether hypertensive patients were administered specific drugs (examples of continuous, or dosage, treatment decisions that allow physicians to experiment).

Bikhchandani, Hirschleifer, and Welch, 1992), but there have been few empirical applications of these theories.

In this paper we examine physician behavior at the micro level in order to measure the extent to which physicians' treatment decisions are influenced by where they trained as a resident, their patients' health outcomes, and their peers' treatment decisions. We find that physicians have distinct practice styles, and that the variation in the risk-adjusted c-section rate between physicians within a region is three times larger than the inter-regional variation. Although treatment styles are associated with where physicians trained, residency programs explain only four to six percent of the variation between physicians in c-section rates. We find evidence that physicians, particularly inexperienced physicians, respond to the practice style of their peer physicians, although the magnitude of this effect is fairly small. For example, a one-standard deviation increase in the lagged c-section rate of a physician's peer group is predicted to increase that physician's c-section rate the subsequent year by 0.6 percentage points if he has been practicing for one year (or a 2.4 percent increase in the sample average c-section rate), versus 0.3 percentage points if he has 12 years of experience. These results indicate that herding behavior is not the primary cause of inter-regional variations in the c-section rate. Physicians also appear to alter their practice style according to their patients' health outcomes. A physician experiencing a one standard deviation increase in the proportion of his vaginal delivery patients who experience an adverse outcome (from 0.042 to 0.079) is predicted to increase his c-section rate by 0.6 percentage points.

Physician Learning and Cesarean Sections

In 1998 over 900,000 cesarean sections were performed in the United States, making it the second most common surgical procedure. The percentage of deliveries performed by c-section increased markedly during the 1970s and 1980s before stabilizing in the last decade, as displayed in Figure 1. Only 5.5 percent of babies were delivered via c-section in 1970, versus 22.0 percent in 1999. The primary c-section rate, which excludes women who have had a prior c-section and thus are more likely to have a c-section on subsequent deliveries, grew at roughly the same rate as the overall rate. In Figure 1 we also display the c-section rate in Florida during the 1990s because we will examine obstetricians' decisions in this state in the empirical section of the paper. The overall c-section rate in Florida tracks the national average.

There is a perception among health insurers, public health organizations, and obstetrician associations that there are too many c-sections performed in general. Women who received a c-section in Florida between 1992 and 2000 remained in the hospital 3.5 days, on average, versus 1.9 days for women who have vaginal deliveries.[4] The hospital average charge for a c-section in Florida in the 1990s was $8,500, almost twice as high as the charge for a vaginal delivery, while the average physician charge for a c-section is about $500 higher than for a vaginal delivery (Gruber, Kim, and Mayzlin, 1999). Furthermore, a number of medical studies conclude that the health outcomes for children and mothers are better with vaginal deliveries than c-sections. Since there apparently are cost and health advantages of vaginal deliveries, the Public Health Service established a goal in 1990 to try to reduce the national c-section rate to 15 percent. As can be seen from Figure 1, this goal has not been achieved.

Cesarean sections are not a new technology, so one might expect information regarding the medically appropriate use of this treatment to have diffused widely, resulting in near uniformity of the c-section rate across regions. However, as with most medical treatments, there is considerable regional variation in the treatment rates. In Figure 2 we report the mean c-section rate for the 11 Florida health districts for 1992. The proportion of deliveries performed by c-section (the c-section rate) ranges from 20.9 percent in district 3 and district 4 (the Jacksonville metropolitan area) to 30.6 in district 10 (the Palm Beach metropolitan area). The coefficient of variation in the c-section rate across these regions is 0.109, which is relatively low according to small area variation studies of other types of medical treatments. If we control for observed

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[4] Based on data from Florida hospitals between 1992-1999.

patient characteristics, the regional mean c-section rates become more similar (the darker bar for each region in Figure 2), and the coefficient of variation across the regions decreases to 0.084.[5]

Most of the small area variation studies focus on variations in regional (e.g., county or state) average use rates based on aggregate hospital data, as opposed to data on individual physicians' use rates. Phelps and Parente (1990) acknowledge that if the use rates vary across physicians within a region, their estimates of welfare loss due to medical practice variations will be too low. That is, even if the mean use rate of a region conforms to best medical practices, there will still be patients receiving too much or too little of the treatment if there is variation across physicians within a region.

To examine this issue in the case of deliveries, we include a full set of physician indicator variables to the regression described above.[6] In Figure 3 we present a histogram of the physician coefficients from the 1992 regression, which can be interpreted as the risk-adjusted probability a physician will perform a c-section, controlling for regional fixed effects. The variation in the c-section rate across physicians within a region is 3.5 times larger than the between-region variation. The standard deviation of the physician fixed-effect coefficients is 0.093, whereas the standard deviation of the risk-adjusted regional coefficients in Figure 2 is 0.026. This implies that two women from the same region who choose their obstetricians randomly will have very different probabilities of receiving a c-section. The main purpose of this paper is to understand what influences these distinct clinical styles.

Phelps and Mooney (1993) propose a model to explain the observed variation in use rates. They argue that physicians form beliefs about the appropriateness and effectiveness of medical technologies during medical school and residency training. When a physician begins practicing medicine, she modifies her prior belief about the appropriateness of a technology or

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[5] Using ordinary least squares, we regress whether or not a woman received a c-section on her age, age squared, race, type of health insurance, day of admission, indicator variables for a woman's health and the status of her pregnancy (e.g., a malpositioned fetus, or severe hypertension), and a full set of regional indicator variables. No constant is included.

treatment method after observing her colleagues' treatment decisions. Observing colleagues' treatment decisions may be a less expensive way for a physician to collect information relative to reading journals and attending continuing medical education conferences, and more immediate colleagues (geographically and within rather than between specialties) should have a greater influence than more remote colleagues.

If physicians' prior beliefs regarding the appropriateness of a technology are drawn from a beta distribution, physicians have a quadratic loss function regarding divergence from their prior and updated beliefs, and physicians value the information received from each physician's practice equally, then a physician's updated belief regarding appropriateness will be:

$$(1) \qquad w(y) = \frac{(\alpha + y)}{(\alpha + \beta + N)} = \frac{(\alpha + \beta)}{(\alpha + \beta + N)} \frac{\alpha}{(\alpha + \beta)} + \frac{N}{(\alpha + \beta + N)} \frac{y}{N}$$

For example, if an obstetrician observed α c-sections and β vaginal deliveries when training as a resident, her prior regarding the appropriate c-section rate for a specified patient type would be would be that $\alpha/(\alpha + \beta)$. Once she begins practicing in a market she observes N deliveries, of which y are c-sections. Equation (1) indicates that the physician's updated belief is a weighted average of her prior and the observed c-section rate in her market, where the weights are the volumes of deliveries observed prior to and since entering the market.

In the Phelps and Mooney model, physicians update their beliefs over time in a Bayesian fashion. Over time the y/N term will dominate equation (1), and physicians' assessment of the technology will coincide with those of their colleagues, thereby forming the "community standard." In practice there is no assurance that physicians value their colleagues' experiences as highly as their own, so it remains an empirical question whether this convergence will occur. If physicians adhere steadfastly to their perceptions formed during residency, their c-section rates should be stable over time and impervious to the behavior of their peer groups.

[6] We omit one regional indicator variable from this regression.

There are a number of other models in the general economics literature where individuals observe the decisions of their peers, update their priors, and decide rationally to herd on the choices of their peers (Banerjee, 1992; Scharfstein and Stein, 1990; Ellison and Fudenberg, 1993, 1995; Bikhchandani, Hirschleifer, and Welch, 1992). Banerjee (1992), for example, describes a model where individuals share a common prior probability that a product is preferred, and each person receives a private signal regarding the product's quality. If the second person in a market observes the first person's choice and regards all signals to be of equal quality, he may infer that the first person received a positive signal regarding the quality of the chosen product, discard his own negative signal, and buy the same product. The third person will then choose the same product regardless of his private signal. Each person exerts a negative externality on the rest of the population when they discard their private signal.

Phelps and Mooney do not discuss the economic implications of physician learning and conforming to the community standard. Whether we interpret convergence to a community standard as a positive or negative phenomenon depends, in part, on whether inexperienced or experienced physicians are more likely to engage in best medical practices. Consider a situation where medical technology is changing rapidly and teaching hospitals are best positioned to assess technology and establish best medical practices. Patient outcomes would improve if newly trained residents arrived in a market, adhered to their priors regarding the efficacy of medical treatments, and established physicians updated their priors based on the treatment decisions of the new physicians. In the Phelps and Mooney (1993) model and the Banerjee (1992) model, if there is an information shock among young physicians, this potentially beneficial information may never diffuse to the entire physician population.

Data

We construct our sample from the Florida discharge data sets for the 1992 to 2000 time period. The data sets contain information on 1.6 million deliveries that occurred at non-federal, short-term acute care hospitals in Florida. We observe some demographic information of the mother (age, race, ethnicity), insurance coverage (e.g., HMO), codes for primary diagnosis and secondary diagnoses, procedure codes that allow us to determine whether the baby was delivered vaginally or via c-section, a unique and consistent (across hospitals and years) physician identifier, a unique and consistent hospital identifier, and the quarter and year the patient was admitted. Sample means and standard deviations for the patient-level data set are reported in Table 1. The diagnoses codes allow us to control for objective health conditions that affect the probability a physician will perform a c-section (e.g., whether a woman has had a c-section prior to this delivery, whether the fetus was malpositioned during the delivery such as in the breech position, or whether the labor occurred before the fetus was full-term). Although none of these health conditions is common, women are much more likely to receive a c-section in these situations.[7]

Since the physician identifiers are consistent and the data include all hospital discharges, we are able to examine a physician's entire inpatient practice over time. We link the physician license numbers to data from the American Medical Association's (AMA) Masterfile to collect information on each physician's gender, race, the residency program(s) where he received training, and the year he completed residency training. We create a variable for years of post-residency experience, and sometimes include an indicator variable for physicians with fewer than four years of experience. We also have information on race for a subset of physicians from the Florida State Medical Board.

We define physician j's peer group in year t as all physicians other than physician j who delivered a baby at the same hospital or hospitals as physician j in year t. Forty-nine percent of the physicians in our data set delivered all their babies at a single hospital, 35 percent divided their deliveries between two hospitals, and 16 percent at three or more hospitals. A physician's

[7] The other two diagnoses frequently associated with a c-section are fetal distress and abnormal labor. Since these assessments are fairly subjective, we do not include these as control variables.

peer group consists of an average of 51 physicians, so most obstetricians can potentially interact with and learn from a large number of their peers. We include all physicians when constructing peer group averages but omit from the regression analysis any physician who delivered fewer than 10 babies in a year.

We aggregate the patients for each physician in each year and present the means and standard deviations of the physician-level data set in Table 2. The physician-level data set contains 1,831 physicians representing 8,429 physician-years. Sixteen percent of the physicians are women and the mean age is 41 years. Physicians in the sample delivered an average of 144 babies per year, whereas the mean quantity of deliveries for a physician's entire peer group was over 4,000. Four percent of the vaginal deliveries resulted in a adverse patient outcome, defined as fetal-maternal hemorrhage, intrauterine death of the fetus, fetal and placental problems, abnormality in fetal heart rate or rhythm, failed forceps or vacuum extractor, prolapse of the umbilical cord, rupture of the uterus, or postpartum hemorrhage.[8] One hypothesis is that physicians who experience a relatively high adverse outcome rate when performing vaginal deliveries will subsequently perform more c-sections. In the next section we describe the method of computing each physician's c-section rate, adjusted for patient characteristics that affect the likelihood of needing such care, as well as the adjusted c-section rate of his peer group.

Methodology

Our objective is to examine whether physicians' perceptions of the usefulness of medical technologies are influenced by their colleagues' perceptions. Since we observe treatment decisions rather than perceptions, we want to control for differences in treatment decisions that are due to differences in patient characteristics rather than physician perceptions. The existing literature on cesarean sections indicates that patients' health conditions and demographic

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[8] We received assistance from Dr. George Macones, the Director of Fetal and Maternal Medicine at the University of Pennsylvania, with defining adverse patient outcomes

characteristics affect the likelihood they will receive a c-section (e.g., Burns, Geller, and Wholey, 1995). For example, women who are relatively old, have health insurance, have had a prior c-section, and whose fetus is malpositioned (e.g., breech – feet first rather than head first) are more likely to receive a c-section. Since patient characteristics can differ substantially across physician practices and, to a lesser extent, within practices over time, we focus our analysis on physicians' regression-adjusted c-section rates – the proportion of a physician's deliveries that are performed by c-section, controlling for observed patient characteristics and regional fixed effects.

To derive the adjusted c-section rates we estimate the following linear probability model, separately for each year between 1992 and 2000:

$$\text{(2)} \qquad \Pr(C_{ij} = 1) = \alpha_0 + \alpha_1\mathbf{X}_i + \alpha_2\mathbf{LHD}_i + \mathbf{Y}_j\mathbf{J} + \varepsilon_{ij}$$

C_{ij} equals one if patient i received a c-section by physician j and is zero otherwise. We include patient characteristics **X**, such as the patient's age, type of health insurance, medical conditions (whether the woman had a c-section in a prior delivery, twins, premature labor, antepartum bleeding), and day of admission, to control for factors that might affect the likelihood of receiving a c-section. We also include a set of indicator variables for 10 of the 11 Florida local health districts (LHD) to allow for regional variation in the use of the procedure.[9] Finally, we include a full set of physician indicator variables **J** to measure the probability that a physician will perform a c-section, relative to the Florida physician average, controlling for observed patient characteristics and average regional differences in treatment patterns. We do not include a constant when estimating equation (2), so the coefficients on the physician indicators measure the likelihood that a particular patient would receive a c-section from each physician, controlling for patient characteristics and regional differences in practice patterns.

The estimated coefficient for each physician j, $\hat{Y}_j$, will incorporate both differences between physicians in unobserved patient characteristics and differences in physicians' perceptions of the appropriateness of c-sections. We are interested only in the latter component and will address below how we attempt to isolate this component. Women with strong preferences for having a c-section and women who know they are at risk of needing a c-section (e.g., a woman whose fetus is breech) may select physicians who are more willing to perform c-sections and/or are skilled at performing them. In general, most obstetricians are members of a group practice, and it is standard for a single obstetrician in the group to have responsibility for all of the practice's deliveries in a given 24-hour period. Many women, therefore, choose their preferred obstetrics practice but not the actual physician who delivers her child. In the subsequent analysis, therefore, we assume that the component of Y_j that is due to unobserved patient characteristics, including patient preferences, is time invariant and will drop out of the panel estimation.

A physician's practice style is assumed to consist of a signal, Y_j, and a noise component, u_j: $\hat{Y}_j = Y_j + u_j$. The coefficients $\hat{Y}_j$ are estimates of a physician's practice style and are likely to be measured with error, particularly for physicians who perform a relatively small number of deliveries. We can measure the variance of the noise component for each physician from the covariance matrix of equation (2). If we assume the variance of Y_j, the true practice style of a physician, is the same for all physicians, we can estimate a unique signal to noise ratio for each physician in the data set. We derive a "filtered" estimate of each physician's practice style by taking a weighted average of each physician's coefficient $\hat{Y}_j$ and the sample mean $\hat{Y}$, where the weights are a physician's signal to noise ratio (which ranges from zero to one) and one minus this ratio, respectively (Kane and Staiger, 2001; McClellan and Staiger, 1999). The coefficients for physicians with a small number of deliveries will therefore be reduced toward the sample mean, whereas the coefficients for physicians who perform a large number of deliveries will not be affected much by the filtering, or "Bayesian shrinkage", method.[10]

[9] Miami, the largest local health district, is omitted.
[10] The mean signal to noise ratio in our data is 0.78.

Phelps and Mooney (1993) propose that a physician's c-section rate for a particular type of patient will be a function of his prior belief regarding the appropriateness of a c-section, and the observed c-section rate of his peer group. We interpret a physician's adjusted c-section rate in period t-1, $Y_{j,t-1}$, as the physician's prior regarding the appropriateness of a c-section. To derive the information physician j receives from his colleagues, we calculate the weighted average adjusted c-section rate of each member of physician j's peer group in period t-1, where the weight is the proportion of the total quantity of deliveries performed by the group (other than physician j) accounted for by each physician (other than physician j).

Using ordinary least squares, we regress physician j's (regression adjusted and filtered) c-section rate in year t on his lagged rate, his peer group's lagged rate, and the proportion of vaginal deliveries performed by physician j in year t-1 that resulted in an adverse patient outcome (A_{t-1}):

(3) $$Y_{jt} = \beta Y_{j,t-1} + \gamma Y^{pg}{}_{j,t-1} + JA_{j,t-1} + \eta_{jt}$$

The coefficients β and γ are the weights physicians place, on average, on their prior information and the information received from his peers.[11] Phelps and Mooney (1993) hypothesize that the weights should be the proportion of deliveries a physician has observed that occurred prior to joining his peer group and since joining his peer group, respectively, and therefore should sum to one.

In our context, Y_{jt} is the c-section rate for physician j controlling for observed patient characteristics and regional (local health district) fixed effects. If a physician's risk-adjusted c-section rate is high in year t-1, β indicates the extent to which it is also high in year t. A value for β that is close to one would indicate that physicians' treatment patterns are persistent. A positive value for γ would indicate that, controlling for a physician's lagged c-section rate, a physician who practices with physicians who collectively have relatively low (high) c-section rates in t-1 will perform fewer (more) c-sections in year t, presumably because the physician is acquiring

[11] In some specifications of equation (3) we include physician characteristics: age, gender, and race.

information from his peer group regarding the best way to treat patients. We include the adverse outcome variable, A, in equation (3) to see if physicians adjust their treatment decisions based on what how their patients fared in the past. All three coefficients (β, γ, and J) can capture physician learning.

There are three potential biases in the specification of equation (3). We assume that the η_{jt} follow a one-way error component model:

(4) $\eta_{jt} = \mu_j + v_{j,t}$

where the μ_j are independent and identically distributed and the $v_{j,t}$ are independent of each other and among themselves (no serial correlation). μ_j is a time-invariant physician fixed effect based on the unobserved health and preferences of a physician's. The lagged dependent variable $Y_{j,t-1}$ that is included as a regressor in equation (3) is correlated with μ_j , and therefore $Y_{j,t-1}$ will also be correlated with η_{jt}, the error term. As a result, the ordinary least squares (OLS) estimate of β will be biased upward.[12] If our data on patient characteristics capture most of the true differences in patients' health and if patients do not choose physicians to a great extent based on their preferences, μ_j will be close to zero and the OLS bias will be minor.

A second potential bias in equation (3) may occur if physicians choose markets based, in part, on whether the physicians in that market practice a similar style of medicine. If new physicians systematically locate among established physicians who share their views, the OLS estimate of γ will be biased upward because $Y^{pg}_{j,t-1}$ will be positively correlated with $Y_{j,t-1}$, and therefore correlated with η_{jt}. Manski (1993) highlights the difficulty of separating the influence of the peer group on a person's behavior from the influence of unobserved characteristics shared by a person and his peer group. In this version of the paper we assume that physicians are randomly assigned to peer groups and thus that $Y^{pg}_{j,t-1}$ is uncorrelated with μ_j. We plan to test the

[12] This part of the paper follows the discussion in Baltagi (2001) regarding the econometric problems associated the dynamic panel estimators.

validity of the hypothesis that the peer group practice style is exogenous by examining the correlation between the c-section rate at the teaching hospital where physicians trained and the c-section rate of the market in which they first locate, and we may explicitly model the market selection decision.

The third potential bias in the OLS specification is that γ may be biased upward if a common shock in t-1, such as increased malpractice pressure, causes a physician's c-section rate and his peer group's rate to move together for reasons other than information the physician receives from his peer group. In future work we will instrument for a peer group's c-section rate using the residency program where each member of the peer group trained. If residency programs impart unique practice styles on training physicians, there will be differences across peer groups in c-section rates due to predetermined factors rather than subsequent (to the location decision) shocks.

One way to address the first two potential biases of the OLS specification is to estimate a fixed effects model that eliminates μ_j:

$$(5) \qquad Y_{j,t} - \bar{Y}_{j} = \beta(Y_{j,t-1} - \bar{Y}_{j.-1}) + \gamma(Y^{pg}_{j,t-1} - \bar{Y}^{pg}_{j.-1}) + J(A_{j,t-1} - \bar{A}_{j.-1}) + (v_{j,t} - \underline{v}_j)\ ,$$

where $\bar{Y}_{j.-1} = G^{T}_{t=2}\, Y_{j,t-1}/(T-1)$, and likewise for $\bar{Y}^{pg}_{j.-1}$ and $\bar{A}_{j.-1}$. (The term $\underline{v}_j$ is the average error for physician j). In some specifications we interact $(Y_{j,t-1} - \bar{Y}_{j.-1})$, $(Y^{pg}_{j,t-1} - \bar{Y}^{pg}_{j.-1})$, and $(A_{j,t-1} - \bar{A}_{j.-1})$ with a physician's quantity of deliveries and experience to see if the effect of learning varies by physician practice characteristics.

The coefficient γ is now identified by variations over time in the c-section rate of a physician's peer group (and β and J are likewise identified by variations over time). If the peer group's c-section rate is high in t-1 relative to its average rate, is the physician's c-section rate also high in year t, relative to his average? In the fixed effects model, a coefficient for β that is close to zero would indicate that physician styles are persistent; when a physician's rate deviates from his average in year t-1, he is likely to return to his average rate in year t. There was considerable turnover of obstetricians in the Florida markets in the 1990s, which creates variation in peer group c-section rates. In Table 3 we display the most common patterns in our data set. Of the 1,831 physicians who delivered at least 10 children in a given year between 1993 and 2000, 623 (34 percent) were present in every year. Six percent of the physicians were present from 1993 to 1996 only, presumably because they stopped practicing medicine or moved from the state thereafter. A total of 254 physicians (13.9 percent) were first observed in 1995, 1996, or 1997 and remained in the data set through 2000, presumably because they entered the state during our sample period. If physicians have different practice styles and do not sort perfectly according to their styles, we should see considerable variation over time in the peer group variable that will help identify the learning effect.

The variable $Y_{j,t-1} - \bar{Y}_{j,-1}$ in equation (5) will be correlated with $v_{j,t} - \underline{v}_j$ because by construction $Y_{j,t-1}$ is correlated with $\underline{v}_j$ (Baltagi, 2001). As a result, the coefficient β will be biased downward. Anderson and Hsiao (1981) suggested taking the first difference of equation (3),

$$Y_{j,t} - Y_{j,t-1} = \beta(Y_{j,t-1} - Y_{j,t-2}) + \gamma(Y^{pg}_{j,t-1} - Y^{pg}_{j,t-2}) + (v_{j,t} - v_{j,t-1}) \quad (6)$$

and using the second lag of the level ($Y_{j,t-2}$) as an instrument for ($Y_{j,t-1} - Y_{j,t-2}$) as suggested by Arrelano (1989). $Y_{j,t-2}$ will be correlated with ($Y_{j,t-1} - Y_{j,t-2}$) but will not be correlated with ($v_{j,t} - v_{j,t-1}$) as long as the $v_{j,t}$ are not serially correlated.[13] If there is a common shock in a market, such as increased malpractice pressure that causes all obstetricians to perform more or fewer c-sections, then the variable ($Y^{pg}_{j,t-1} - Y^{pg}_{j,t-2}$) in equation (5) may be correlated with ($v_{j,t} - \underline{v}_j$). Therefore we also instrument for ($Y^{pg}_{j,t-1} - Y^{pg}_{j,t-2}$) using the second lag of the level ($Y^{pg}_{j,t-2}$).

Arrelano and Bond (1991) developed a generalized method of moments estimator that is more efficient than the Anderson and Hsiao (1981) estimator. In future work we will implement the Arrelano and Bond estimator, which will take into account the serial correlation of the error structure and use additional instruments such as a physician's age, gender, race, and residency program. The inclusion of the residency program as an exogenous source of variation in the peer group's c-section rate will help address the third potential bias mentioned above: a physician's rate and his peer group's rate may move together due to a common market shock rather than due to information acquisition and updating one's prior regarding medical efficacy.

Results

The first step in our analysis is to adjust a physician's c-section rate for the type of patients he treated in a particular year. To do this we estimate a linear probability model (equation 2) where the unit of observation is a delivery, and the dependent variable is one if woman received a c-section and zero otherwise. This regression is estimated separately for each year between 1992-2000, and in Table 4 we present coefficient estimates from the ordinary least squares estimation for 2000.

Although the primary purpose of this regression is to recover the coefficients on the physician indicator variables, the coefficients are interesting nevertheless. These coefficients can be interpreted as the change in a patient's probability of receiving a c-section associated with a change in the independent variable. Although the health conditions we include are uncommon (none is present in more than five percent of the women), they have a substantial impact on the probability that a woman will have a c-section. For example, a woman with severe hypertension has a probability of receiving a c-section that is 36.1 percentage points higher than women without that condition. The probability that a black or Hispanic woman receives a c-section is 0.6 and 1.8 percentage points higher, respectively, than for a white woman. Women who have Medicaid and uninsured women are less likely to receive a c-section, as are older women.

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[13] One could also use ($Y_{j,t-2}$ - $Y_{j,\, t-3}$) as an instrument, but Arrelano (1989) recommends $Y_{j,t-2}$ because it usually has smaller variances over a significant range of parameter values.

Medicaid generally reimburses physicians and hospitals less than private insurers, so our result is consistent with Gruber, Kim, and Mayzlin (1999) who find that higher fee differentials between c-sections and normal deliveries lead to higher c-section rates. Women who are admitted on a Friday have a slightly higher probability of having a c-section, while women admitted on the weekend have a considerably lower chance of having a c-section. Few if any c-sections are scheduled for the weekend, while the higher rate on Friday may occur if there is less anesthesiology coverage on the weekend (required for a c-section) than during the week.[14]

Once we run a separate regression like the one reported in Table 4 for each year, we recover the physician coefficients, adjust the coefficients using the filtering method described above, and create a panel data set. We also use the filtered coefficients on the physicians in physician j's peer group (physicians who deliver babies at the same hospital as physician j in year t-1) to create a lagged, delivery-weighted peer group c-section rate for each physician for each year.

We begin by pooling the physician risk-adjusted and filtered c-section rates for all physicians over the 1992-2000 time period, and regressing these rates on a full set of physician indicator variables. In Figure 4 we plot a histogram of the physician coefficients over the entire 1992-2000 period, much as we did in Figure 3 for a single year. As before, there is considerable variation in physician practice styles; the standard deviation of the coefficients (0.061) is three times larger than the standard deviation of the risk-adjusted c-section rate between the 11 Florida regions (0.021) over this time period. Furthermore, the physician fixed effects explain 63 percent of the variation in the risk-adjusted c-section rates, and 29 percent of the coefficients on the

[14] There may also be more c-sections scheduled for Friday than the other days so that women can begin recuperating over the weekend.

physician indicators are significantly different from the sample mean c-section rate.[15] These results indicate that many physicians have distinct clinical styles.

In column 1 we regress the physician risk-adjusted and filtered c-section rates on physician characteristics only. Female physicians have a 1.5 percentage point lower c-section rate than male physicians, on average. Family practitioners and internists have lower rates than physicians in "other" specialties (the omitted group), presumably because they only treat women with uncomplicated pregnancies and health histories who have relatively good unobserved health characteristics. Physician characteristics only explain about two percent of the variation in c-section rates, as indicated by the R^2 in column 1.

In column 2 of Table 5 we include indicator variables for the 114 residency programs that trained at least five physicians in our data set to see whether programs impart distinct styles on their residents that persist once they start practicing. The residency programs collectively explain an additional four percent of the variation across physicians in their risk-adjusted c-section rates. About one-quarter of the coefficients on the residency program indicator variables are significantly different from the reference group (all residency programs that trained fewer than five physicians in our data set, which is the modal group) at the five-percent level.

We repeat this regression in column 3 on physicians with fewer than four years of experience to see if residency programs have a stronger effect on the practice styles of newly trained physicians, perhaps because they have yet to fully incorporate the practice styles of their peers and the health outcomes of their patients into their own treatment decisions. The adjusted R^2 of 0.17 in column 3 is 0.06 larger than a similar regression (not shown in Table 5) that omits the residency fixed effects for the smaller sample of inexperienced physicians, and 40 percent of the residency program coefficients are significant. This indicates that residency training explains

[15] To determine how many physicians have a practice style different from the sample mean we omitted a physician from the regression who had a large quantity of deliveries and had a c-section rate close to the sample average. We omitted the constant from this regression.

more of the variation in c-section rates among inexperienced physicians than among all physicians, but still does not explain a considerable amount.

We present coefficient estimates of the fixed effects model specified in equation (5) in Table 6. In the column 1 we include a physician's peer group's lagged c-section rate, his own lagged rate, and the adverse outcome variable. These coefficients are identified by variation over time in a physician's c-section rate, his peer group's rate, and his adverse outcome rate. There appears to be a reasonable amount of variation over time within a physician to identify these three coefficients. The standard deviation of the peer groups' lagged c-section rate between physicians is 0.040 and within physicians (over time) is 0.036 (with a mean of 0.088); the standard deviation of the physicians' lagged c-section rate is 0.053 between physicians and 0.044 within physicians (over time), with a mean of 0.091; and the standard deviation of adverse outcomes is 0.031 between physicians and 0.023 within physicians (over time), with a mean of 0.037.

The peer group and own lagged c-section coefficients in the first column of Table 6 are positive, as expected.[16] The coefficient of 0.048 on a physician's lagged c-section rate is close to zero, and indicates that physician treatment styles are quite persistent. If the (regression-adjusted) c-section rate of a physician's peer group increases by one standard deviation (4.6 percentage points), that physician's c-section rate is predicted to increase by 0.3 percentage points. This represents a 1.2 percent increase for a physician with the sample mean (unadjusted) c-section rate of 27.6 percent. Physicians do appear to learn from the treatment decisions of their peers, but the impact is relatively small.

The coefficient on the proportion of a physician's vaginal deliveries in the prior year that resulted in an adverse patient outcome is positive. As expected, physicians appear to perform more c-sections when their patients have relatively bad health outcomes with the less aggressive

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[16] Both coefficients are smaller in magnitude in the fixed-effects specification than the OLS specification (not shown), which is consistent with physician-patient sorting based on unobserved health characteristics or preferences. The coefficient on a physician's lagged rate in the fixed-effects specification is about one-

treatment method. A physician experiencing a one standard deviation increase in their adverse outcome rate (from 0.042 to 0.079) is predicted to increase his c-section rate by 0.6 percentage points. The impact of patient outcomes on a physicians' treatment style appears to be twice as large in magnitude as the impact of learning from one's peers.

In the second column of Table 6 we include a physician's lagged quantity of deliveries and interact this variable with his peer group's lagged rate and his own lagged c-section rate. The former interaction term is negative and the latter interaction term is positive. This indicates that physicians who perform a relatively large number of deliveries are less strongly influenced by the treatment styles of their peers, and have more persistent styles altogether. As expected, high-volume physicians obtain more of their information from their own practice and less from the practices of their peers.

We interact a physician's experience with the c-section rate of his peer group, the physician's own c-section rate, and the proportion of a physician's vaginal deliveries that resulted in an adverse health event in the third column of Table 6 to examine whether peer groups and health outcomes have a relatively strong influence on inexperienced physicians. As expected, the coefficient on the experience*peer c-section rate variable is negative and significant. The effect of a peer group is twice as large for a physician who just completed residency training as it is for the average physician, and the influence of a peer group disappears altogether for physicians with 18 or more years of experience. Similarly, adverse patient outcomes affect a physician's treatment decisions more profoundly for inexperienced physicians. A one-standard deviation increase in the adverse patient outcomes for a physician with one year of experience is predicted to increase his c-section rate the following year by 0.9 percentage points (or a 3.2 percent increase in the sample average unadjusted c-section rate), whereas the effect for a physician with 25 years of experience would be 50 percent smaller.

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tenth as large as in the OLS specification, and the coefficient on the peer group variable in the fixed-effects specification is about one-half as large as in the OLS specification.

As discussed in the previous section, the coefficients on the two lagged c-section rate variables will be biased downward because of correlation with the error term by construction. In Table 7 we report coefficient estimates from the Anderson and Hsiao (1981) first-difference specification described in equation (6). We instrument for ($Y_{j,t-1}$ - $Y_{j,\,t-2}$) with $Y_{j,\,t-2}$, and instrument for ($Y^{pg}{}_{j,t-1}$ - $Y^{pg}{}_{j,t-2}$) with $Y^{pg}{}_{j,t-2}$. In the first column of Table 7 the coefficient of 0.146 on a physician's lagged c-section rate is larger than in the fixed effects specification, as expected. Since this coefficient is still close to zero, physicians' treatment styles appear to be fairly persistent; physicians converge rapidly to their average rate following a deviation from their average rate. The coefficient on the c-section rate of a physician's peer group is positive but insignificant in column 1.

In columns 2 and 3 of Table 7 we include interaction terms between the c-section rates and the quantity of a physician's deliveries (column two) and experience (column three). The coefficient on the adverse patient outcome variable is slightly larger than in the fixed-effects specification. The coefficient on the interaction of physician experience and the peer group c-section rate in column 3 is negative and significant at a 10-percent level, and of similar magnitude to the comparable interaction coefficient in Table 6.

Conclusions

In this paper we test a model of physician learning using a unique data set that contains the universe of hospital admissions in Florida over a 9-year period and consistent physician identifiers. These data allow us to examine physicians' treatment decisions over an extended time period, to characterize a physician's peer group, to observe the treatment decisions of a physician's peer group, and to observe patient outcomes. We examine the extent to which an obstetrician's decision regarding whether or not to perform a cesarean section is influenced by the residency program where he trained, his peer group's lagged c-section rate, and his patients' health outcomes, controlling for patient characteristics.

There are fairly large differences in the mean c-section rates between the 11 regions of Florida, controlling for patients' observed characteristics. The risk-adjusted probability a woman will have a cesarean section ranges from a low of 0.211 in Jacksonville to a high of 0.293 in Palm Beach. There are even larger differences in c-section rates between physicians within a region; the standard deviation of the within-region c-section rate across physicians is three times larger than the between region variation, controlling for observed patient characteristics. Four percent of the variation in c-section rates among physicians can be explained by where they trained as a resident, so educational institutions appear to contribute to the observed regional variation in the type of medical care received but are not the primary factor.

We find that physician clinical styles are persistent. We do, however, find evidence that physicians, particularly inexperienced physicians, respond to the practice style of their peer physicians. A one-standard deviation increase in a peer group's lagged c-section rate is predicted to increase a physician's c-section rate by 0.6 percentage points for a physician who has been practicing for one year (or a 2.4 percent increase in the sample average c-section rate), versus 0.3 percentage points for a physician with 12 years of experience. Physicians also appear to alter their practice style according to how well their patients have fared in the past. A physician experiencing a one standard deviation increase in their adverse outcome rate (from 0.042 to 0.079) is predicted to increase his c-section rate by 0.6 percentage points. These results indicate that herding behavior is not the primary cause of inter-regional variations in the c-section rate.

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Table 1

Sample Means and Standard Deviations in Patient-level Data Set
(n = 1,670,991)

	Mean	Standard Deviation
Age	26.8	6.20
White	0.575	0.494
Black	0.212	0.409
Hispanic	0.154	0.361
Other race	0.0589	0.235
Health insurance		
- PPO and indemnity	0.284	0.451
- HMO	0.218	0.413
- Other private insurance	0.028	0.164
- Medicaid	0.388	0.487
- Uninsured	0.0825	0.275
Woman's health condition:		
Woman has had a previous c-section	0.044	0.206
Malpositioned fetus	0.030	0.171
Antepartum bleeding	0.0096	0.097
Severe hypertension	0.0037	0.061
Preterm gestation	0.0318	0.176
Multiple gestation	0.0054	0.073
Soft tissue disorder	0.0165	0.127
Macrosomia	0.0171	0.130
Oligohydramnios	0.0036	0.060
Polyhydramnios	0.0118	0.108
Herpes	0.0107	0.103
Day of admission:		
- Monday – Thursday	0.643	0.479
- Friday	0.148	0.355
- Saturday	0.103	0.304
- Sunday	0.106	0.307

Table 2

Sample Means and Standard Deviations in Physician-level Data Set
(n = 1,831 physicians and 8,429 physician-years)

	Mean	Standard Deviation
Physician's adjusted c-section rate, t-1	0.062	0.061
Physician's quantity of deliveries, t-1	143.7	120.6
Female	0.207	0.405
Gender missing	0.152	0.359
Non-white	0.093	0.290
Race missing	0.660	0.474
Post-residency experience (years)	12.5	8.43
Physician has < 4 years of experience	0.142	0.349
Age	45.1	8.94
Specialty		
- ob/gyn	0.843	0.364
- family practice/internal medicine	0.033	0.179
- maternal and fetal medicine	0.020	0.044
- other	0.104	0.307
Peer group's adjusted c-section rate, t-1	0.066	0.045
Peer group's annual quantity of deliveries	4017	2819
Proportion of vaginal deliveries resulting in a "bad" outcome	0.040	0.036

Note: adjusted c-section rate is the coefficient on a physician indictor in a cross-section ordinary least squares regression where the unit of observation is a delivery and dependent variable is one if a woman received a c-section, and zero otherwise.

Table 3

Number of Physicians in Data Set by Year of Entry and Exit

	1993	1994	1995	1996	1997	1998	1999	2000
623 physicians	X	---	---	---	---	---	---	X
117 physicians	X	---	---	X				
61 physicians	X	---	X					
59 physicians			X	---	---	---	---	X
68 physicians				X	---	---	---	X
127 physicians					X	---	---	X
71 physicians						X	---	X
74 physicians							X	X
69 physicians								X
<u>562</u> physicians	Other patterns (e.g., 1994-1996)							
1,831 physicians total								

Table 4

Coefficient Estimates From a Patient-level Regression, 2000

	Coefficient	Standard Error
Age	0.00152	0.00118
Age squared	0.00009**	0.00002
Black	0.0059**	0.0027
Hispanic	0.018**	0.0030
Health insurance (PPO and indemnity omitted)		
- HMO	0.0017	0.0027
- Medicaid	-0.0089**	0.0029
- Other private insurance	-0.0132*	0.0072
- Uninsured	-0.0511**	0.0043
Woman's health condition:		
Woman has had a previous c-section	0.338**	0.0048
Malpositioned fetus	0.404**	0.0053
Antepartum bleeding	0.236**	0.0093
Severe hypertension	0.361**	0.0146
Preterm gestation	0.131**	0.0052
Multiple gestation	0.192**	0.0080
Soft tissue disorder	0.323**	0.0067
Macrosomia	0.295**	0.0065
Oligohydramnios	0.237**	0.0147
Polyhydramnios	0.244**	0.0080
Herpes	0.194**	0.0080
Day of admission (Monday-Thursday omitted)		
- Friday	0.010**	0.0026
- Saturday	-0.063**	0.0032
- Sunday	-0.070**	0.0031
Observations	197,397	
R^2	0.38	

Notes: indicator variables are included for 10 of the 11 local health districts and whether the patient's race or age is missing. We also include a full set of physician indicator variables. ** = significantly different from zero at the 5-percent level; * = significantly different from zero at the 10-percent level.

Table 5

Influence of Physician Characteristics and Residency Programs on Physician Practice Styles

	Physician characteristics	With residency programs; entire sample	W/ residency prog; inexperienced physicians only
Experience (years)	0.00009	0.00003	-0.0026*
	(0.00014)	(0.00014)	(0.0015)
Female	-0.0153**	-0.0151**	-0.0126**
	(0.0027)	(0.0027)	(0.0043)
Non-white	0.0038	-0.0009	-0.0023
	(0.0042)	(0.0043)	(0.0058)
Race missing	0.0094**	0.0070**	0.0193**
	(0.0025)	(0.0026)	(0.0046)
Specialty ("other" is omitted)			
Obstetrics	-0.0208**	-0.0197**	-0.0724**
	(0.0104)	(0.0097)	(0.0201)
Ob/gyn	-0.0176**	-0.0186**	-0.0403**
	(0.0044)	(0.0045)	(0.0074)
Family practice	-0.0319**	-0.0252**	0.0009
	(0.0081)	(0.0088)	(0.0191)
Internal medicine	-0.0333**	-0.031**	-0.0175
	(0.0114)	(0.0099)	(0.0136)
General practice	0.0124	0.0109	-0.0462**
	(0.0186)	(0.0188)	(0.0228)
Maternal and fetal medicine	-0.0172**	-0.0165**	-0.0328*
	(0.0075)	(0.0078)	(0.0176)
Constant	0.106**	0.109**	0.126**
	(0.0049)	(0.0050)	(0.0079)
Residency programs jointly significant?		YES	YES
Percent of residency coefficients significant at 5-percent level		24%	40%
Observations	10,528	10,528	1,966
Adjusted R^2	0.02	0.06	0.17

Notes: Dependent variable is a physician's risk-adjusted c-section rate. ** = significantly different from zero at the 5-percent level; * = significantly different from zero at the 10-percent level. Sample is larger than in subsequent tables because we include 1992 in the above regressions, but exclude observations from 1992 when we include lagged variables as regressors.

Table 6: Coefficient Estimates from the Fixed Effect Estimator

	(1)	(2)	(3)
Peer group's c-section	0.0694**	0.121**	0.134**
rate, t-1	(0.0204)	(0.0314)	(0.0345)
Peer group's rate * MD's		-0.0440**	
quantity of deliveries (00)		(0.0186)	
Peer group's lagged rate			-0.0074**
* MD's experience			(0.0023)
Physician's c-section	0.0477**	-0.0164	0.0685**
rate, t-1	(0.0168)	(0.0254)	(0.0294)
Physician's lagged rate *		0.0514**	
MD's # of deliveries (00)		(0.0158)	
Physician's lagged rate			-0.0015
* experience			(0.0018)
Vaginal deliveries in t-1 with	0.167**	0.168**	0.236**
an adverse outcome	(0.0222)	(0.0222)	(0.0392)
Adverse outcome in t-1 *			-0.0046*
experience			(0.0025)
MD's # deliveries, t-1 (00)		-0.0018	
		(0.0014)	
Constant	0.0716**	0.0746**	0.0733**
	(0.0017)	(0.0028)	(0.0017)
Observations	8,429	8,429	8,429
R^2	0.01	0.02	0.02

Notes: the estimator includes fixed effects for physician and year. ** = significantly different from zero at the 5-percent level; * = significantly different from zero at the 10-percent level.

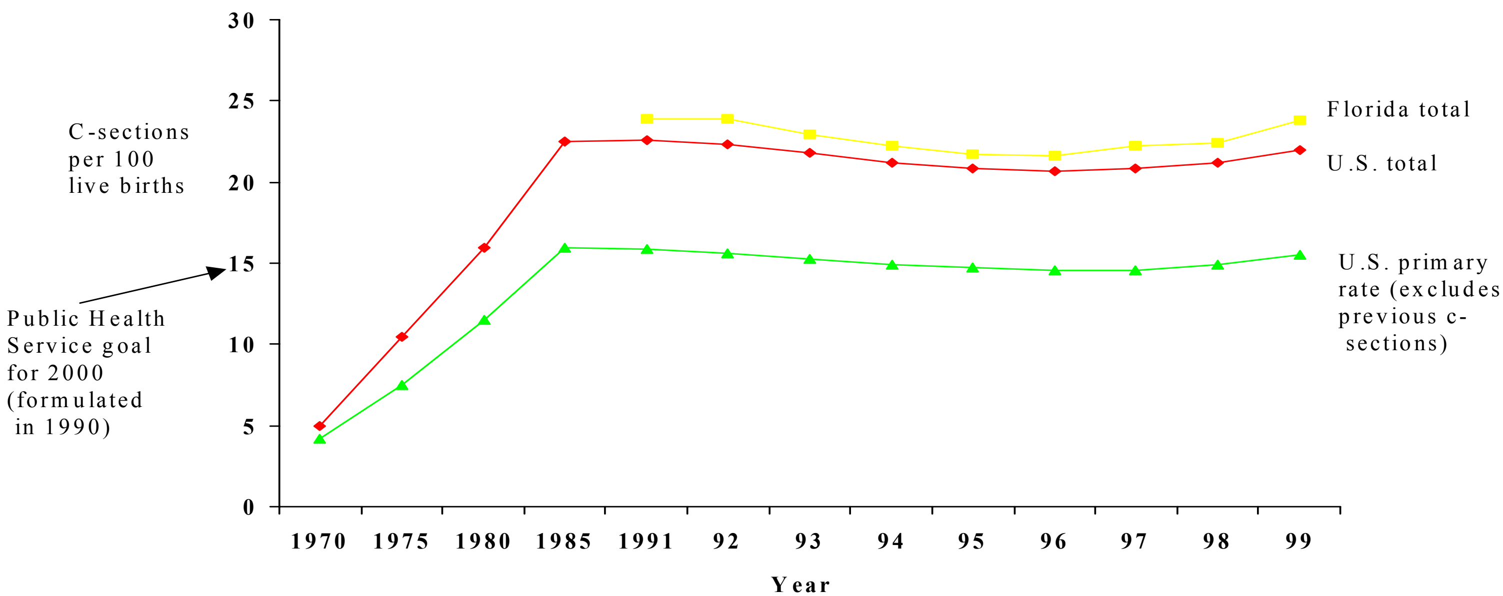
Table 7: Coefficient Estimates From the First-Difference Model

	(1)	(2)	(3)
Peer group's c-section rate, t-1	0.0375	0.0309	0.130**
	(0.0339)	(0.0592)	(0.0641)
Peer group's rate * MD's quantity of deliveries (00)		0.0024	
		(0.0375)	
Peer group's lagged rate * MD's experience			-0.0075*
			(0.0041)
Physician's c-section rate, t-1	0.146**	0.128**	0.191**
	(0.0289)	(0.0512)	(0.0540)
Physician's lagged rate * MD's # of deliveries (00)		0.0102	
		(0.0364)	
Physician's lagged rate * experience			-0.0028
			(0.0034)
Vaginal deliveries in t-1 with an adverse outcome	0.222**	0.221**	0.167**
	(0.0301)	(0.0299)	(0.0534)
Adverse outcome in t-1 * Experience			0.0044
			(0.0033)
MD's # deliveries, t-1 (00)		0.0014**	
		(0.00039)	
Constant	0.0019**	-0.0002	0.0019**
	(0.0004)	(0.0008)	(0.0004)
Observations	6,669	6,669	6,669

Notes: These equations are estimated with two stage least squares. The change in a physician's c-section rate between year t-2 and t-1 is instrumented with the c-section rate in t-2, and the change in a physician's peer group rate between year t-2 and t-1 is instrumented with the c-section rate in t-2. Interaction terms are likewise instrumented. Standard errors are robust and adjusted for clustering by physician. ** = significantly different from zero at the 5-percent level; * = significantly different from zero at the 10-percent level.

Figure 1

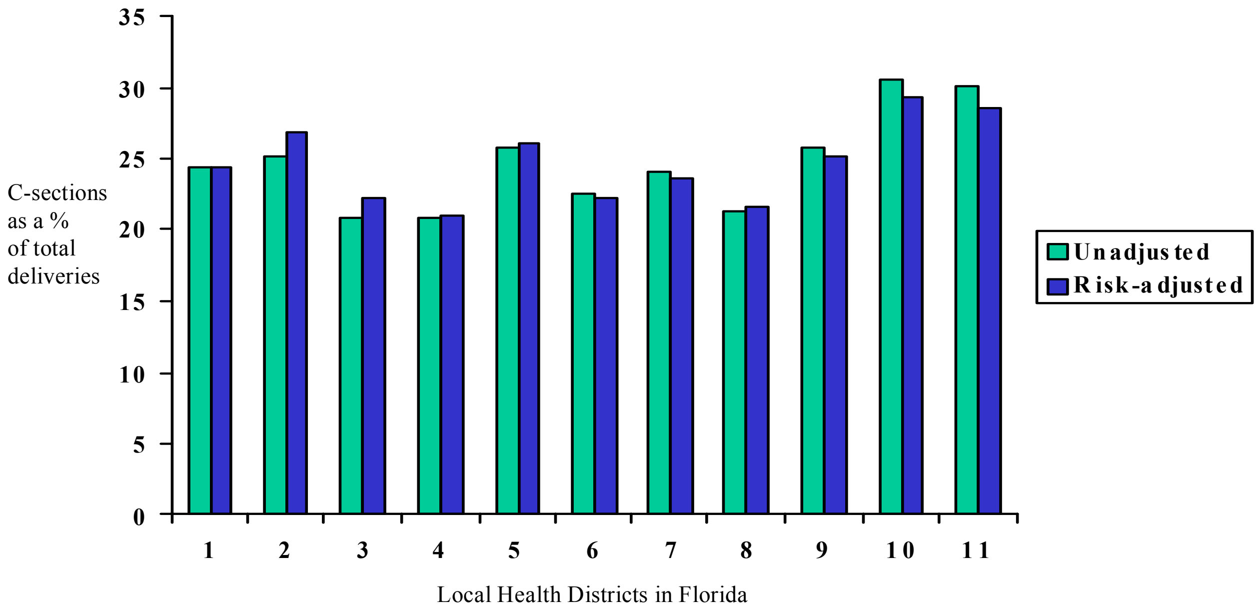
Overall and Primary Cesarean Section Rate for U.S. and Florida, 1970-1999



Source: National Center for Health Statistics.

Figure 2

Mean Cesarean Section Rate by Local Health District in Florida, 1992

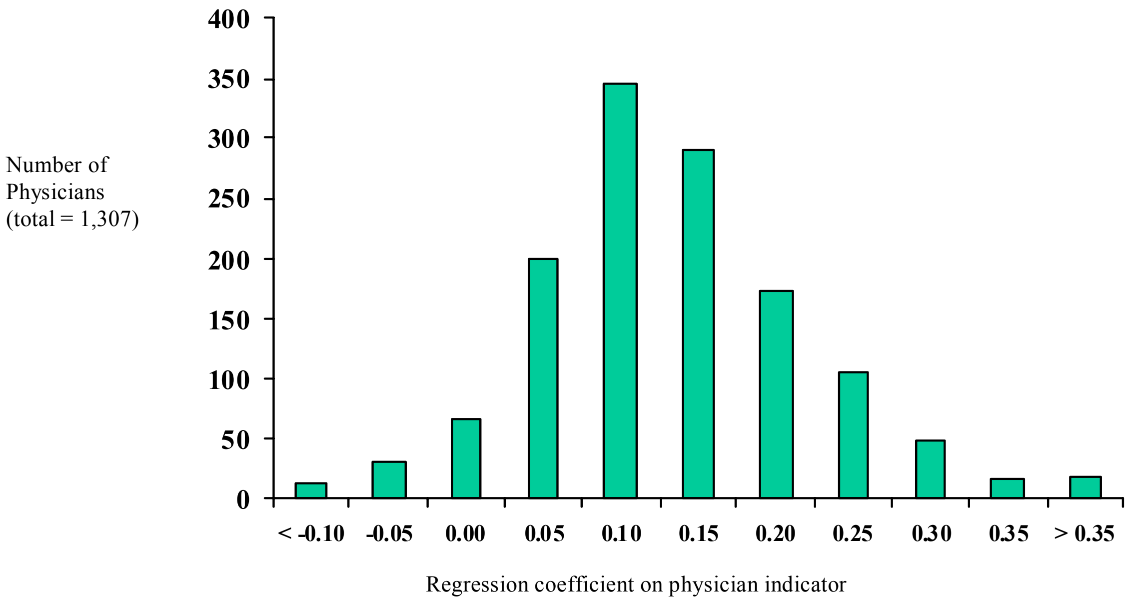


Coefficient of variation **without** patient controls (unadjusted):	0.109
Coefficient of variation **with** patient controls (adjusted):	0.084

Note: coefficients on Florida regional indicator variables from an ordinary least squares regression where the dependent variable is 1 if a woman had a c-section, and is zero otherwise.

Figure 3

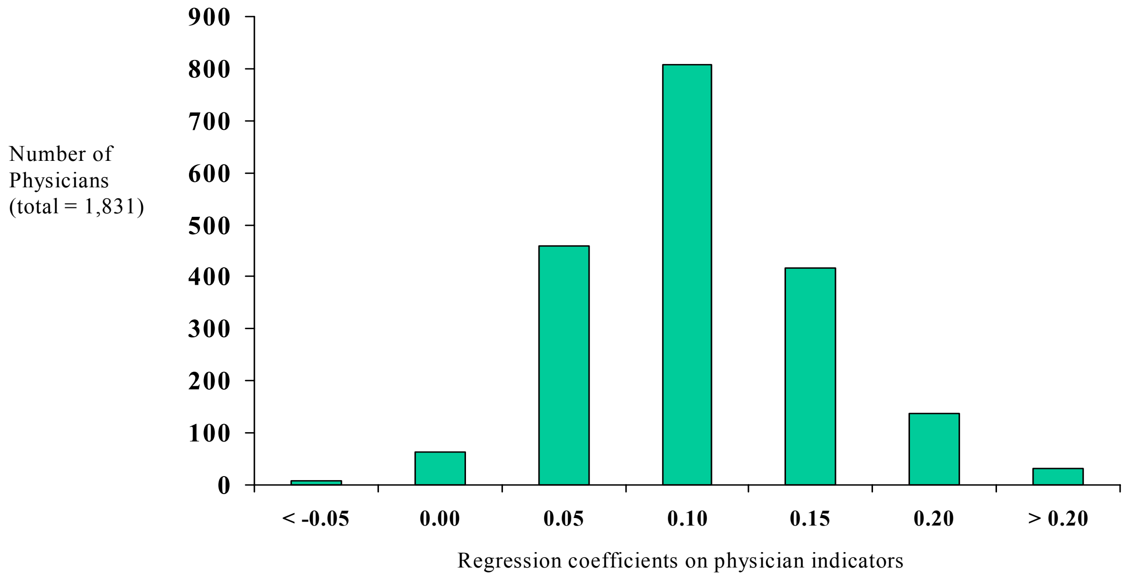
Histogram of Physician Fixed Effects for 1992 (from OLS regression w/ patient characteristics and region indicator variables included)



Standard deviation of physician fixed effects, 1992:	**0.093**
Standard deviation of regional risk-adjusted c-section mean rates, 1992:	**0.026**

Figure 4

Histogram of Physician Fixed Effects from 1993-2000 Pooled Regression



Standard deviation of risk-adjusted physician fixed effects, 1993-2000 pooled:	**0.061**
Standard deviation of risk-adjusted, mean regional c-section rate, 1993-1999:	**0.021**